ORIGINAL ARTICLE

Use of modified-NUTRIC score to assess nutritional risk in surgical intensive care unit

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Abstract

Background: Modified Nutrition Risk in the Critically Ill (m-NUTRIC) score is used to evaluate the nutritional risk of patients in intensive care units (ICUs). This study aimed to investigate whether m-NUTRIC can be used as a predictive factor related to the outcome of patients in surgical ICU (SICU) and to identify which patients will benefit from aggressive nutritional intervention according to the results of m-NUTRIC score.

Methods: A total of 205 patients who were admitted to surgical ICU (SICU) with ventilator use for more than 24 hours were enrolled. The m-NUTRIC score data were calculated the day when the patients were admitted to SICU. Patients were divided into two groups according to their m-NUTRIC score: the low-risk group (<5 points, 116 patients) and the high risk group (≥5 points, 89 patients).

Results: In this study, a total of 205 patients were enrolled for analysis, including patients in the low-risk group (n = 116) and those in the high risk group (n = 89). The mean duration of ventilator use was 3.6 ± 6.5 days, and average SICU stays for all patients was 5.1 ± 7.4 days. The SICU mortality was significantly higher in the high-risk group (10.3% vs 1.7%). Comparison between survivals and nonsurvivals was carried out, and the data showed that the AKI, Vasopressors, SOFA, APACHE-II, m-NUTRIC score, and shock patient were all significantly associated with higher mortality. The multivariate analysis revealed that acute kidney injury (OR = 13.16; 95% confidence intervals = 3.69–46.92; $p < 0.0001$) and m-NUTRIC score were independent factors of ICU mortality in these patients. A receiver operating characteristic curve was used to calculate the area under the curve, which was 0.801. The data indicated that high m-NUTRIC score were significantly associated with SICU mortality with the cutoff score > 4 (sensitivity = 90.5%, specificity = 62.3%, $p < 0.001$).

Conclusion: We found in this study that the high m-NUTRIC score is an independent factor of ICU mortality, and m-NUTRIC score can be used as an initial screening tool for nutritional assessment in patients admitted to surgical ICU. Further investigations to evaluate whether the aggressive nutritional intervention would be beneficial in the SICU patients with higher m-NUTRIC score is mandatory.

Keywords: Critical care; Modified-NUTRIC score; Nutrition; Outcome

1. INTRODUCTION

Malnutrition in critically ill patients is associated with increased nosocomial infections, hospital stays, and mortality.[1] Special metabolic responses caused by stress during the acute phase of illnesses have been observed in all patients in intensive care units (ICU), including hyperglycemia, increased catabolism, proteolysis, muscle wasting, and so on.[2] An early intervention of nutritional support or therapy is indicated in these patients to reduce these side effects and oxidative cell damage.

There are some screening tools available to evaluate the nutritional status of the patients in ICU, including the Nutrition Risk Screening 2002 (NRS-2002), Malnutrition Universal Screening Tool (MUST), and Nutrition Risk in the Critically ill (NUTRIC), however, which scoring system is the best for evaluation of nutritional risk in the ICU patients is debatable.[2–5]

The European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines in 2019 suggested that nutritional evaluation should be performed in all patients admitted in ICU for more than 48 hours.[6] The American Society for Parenteral and Enteral Nutrition (ASPEN)/Society for Critical Care Medicine (SCCM) guidelines recommend that the NRS-2002 and NUTRIC scores can be used as the initial screening tools to assess nutritional risks of the patients in ICU.[7,8] The NRS-2002, which includes a measurement of body mass index (BMI), is widely recognized

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among nutritional societies as the most popular screening tool.[9,10] However, during the initial period of disease in critically ill patients, body weight may change due to disease-induced edema and resuscitation that may lead to an unstable hemodynamic status, and, consequently, BMI may not be accurate.[1] Also, the NRS-2002 may not be proper in patients subjected to ventilators since these patients could not provide the past history of body weight loss and the food intake in detail. Thus, using the NRS-2002 score to evaluate the nutritional status of critically ill patients may not always be efficient.

Heyland et al[7] developed the Nutrition Risk in the Critically Ill score (NUTRIC score) in 2011, a nutritional risk assessment tool aimed to identify critically ill patients who will most likely benefit from aggressive nutritional supplementation. The NUTRIC score consists of 6 variables: age, Acute Physiology and Chronic Health Evaluation II (APACHE-II), Sequential Organ Failure Assessment (SOFA), comorbidities, ICU stay, and serum interleukin-6 (IL-6). The total score ranges from 0 to 10 points, and patients with a NUTRIC score higher than 6 are considered in high risk and worse prognosis, compared with patients with a NUTRIC score lower than 6.[7,11–14] Using this score for risk evaluation allows to easily obtain not only the severity of the patients' state but also the comorbidities as well as other risk factors.[15]

However, the NUTRIC score is not commonly used in most of the hospitals, since it is not easy to measure serum IL-6 on a daily basis. Rahman et al developed a modified-NUTRIC score (m-NUTRIC score), excluding the value of serum IL-6 and pointing out that this new score system does not affect the accuracy of the NUTRIC score as a tool for assessing the nutritional status of patients in ICU. The total score in the modified-NUTRIC score ranges from 0 to 9.[2,7,8,14] Patients in ICU may receive nutritional intervention according to the results of the scoring system, resulting in better outcomes.

Currently, most hospitals in Taiwan use NRS-2002 and MUST as tools for nutritional screening. By contrast, few hospitals use m-NUTRIC score to assess nutritional risk in critically ill patients. This study aimed to investigate whether m-NUTRIC can be used as a predictive factor related to the outcome of patients in surgical ICU and to identify which patients will benefit from aggressive nutritional intervention according to the results of m-NUTRIC score.

2. METHODS

2.1. Study Participants

This is a retrospective observational study from the patients admitted to surgical intensive care unit (SICU) at a single medical center with a total of 817 beds in Taipei, Taiwan, from January 2018 to July 2018. This study has been approved by the Institutional Review Board of Shin Kong Wu Ho-Su Memorial Hospital performs and approved the retrospective study, and the requirement for informed consent were waived for the study (IRB:20190503R). The total number of beds in the SICU is 19. The study population consisted of 716 patients who were admitted to SICU with ventilator use for more than 24 hours. The m-NUTRIC score data were calculated 24 hours after admission into the SICU. Patients who were readmitted to SICU during the same hospitalization period, or those who were transferred to another ICU during hospitalization, or those who had insufficient data to obtain m-NUTRIC score were excluded (Fig. 1).

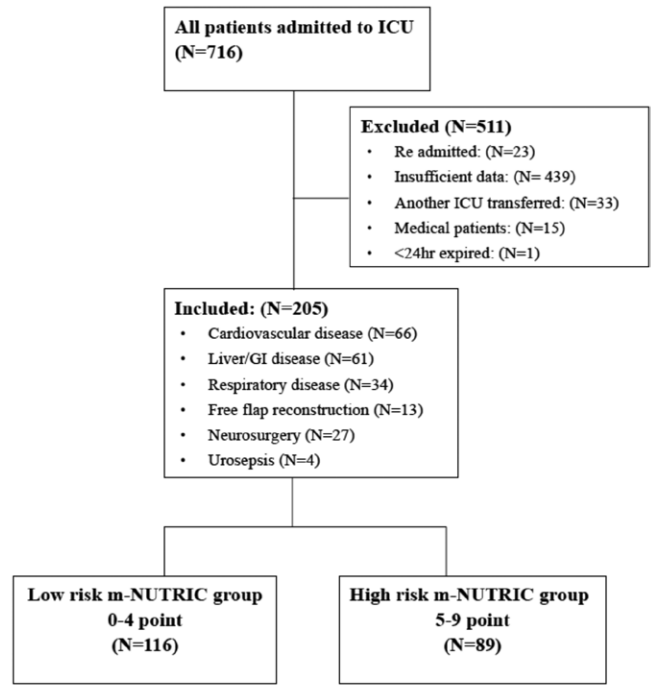

Fig. 1 Flowchart of patients' cohort.

2.2. Data Collection

The data were collected by electronic medical records. The clinical data collected included gender, age, comorbidities, Charlson Comorbidity Index, shock, use of vasopressors/inotropics, ongoing infections after admitted ICU (including blood, sputum, urine, wound infection), duration of ventilator use, length of ICU stay, and ICU mortality. The APACHE-II, SOFA score, BMI, Body Surface Area (BSA) was calculated the day when the patients were admitted to SICU. The patient's body weight was calculated by bed scale. Since serum IL-6 is not routinely measured in our institution, a modified-NUTRIC (m-NUTRIC) score was used in this study for analysis. Patients were divided into two groups according to the m-NUTRIC score. Patients in the low-risk group had m-NUTRIC score <5, while patients in the high risk group had m-NUTRIC score ≧5.

2.3. Statistical Analysis

IBM SPSS version 22.0 statistical software was used in this study. Continuous variables were presented as mean ± standard deviation, and comparison between groups were assessed using the Student t-test. The category variables were presented as percentages and analyzed using Pearson's chi-squared test and Fisher's exact test. Logistic regression was used to surgery-related risk factors. Survival analysis was calculated using Kaplan-Meier survival. ROC (receiver operating characteristic) was used to predict the risk of mortality, and the Youden index was applied to realize the threshold for high nutritional risk. p value <0.05 was considered statistically significant.

3. RESULTS

In this study, a total of 205 patients were enrolled for analysis, including patients in the low-risk group (n = 116) and those in the high risk group (n = 89). The patient characteristics are shown in Table 1. As for other relevant variables, the average values were as follows: age of all patients, 63.9 years old; 63 of 205 patients are male (30.7%); BMI, 24.6 ± 6.4; SOFA score, 6.2 ± 5.2; APACHE-II, 14.8 ± 5.2, and the mean m-NUTRIC score was 4.5 ± 1.8. There were 74 patients (36.1%) who had some infection. Forty-four of these 74 patients are in the high

Table 1

Comparison of demographic data in patients with low and high m-NUTRIC score in SICU

Variables	All patients (n = 205)	Low-risk group (n = 116)	High-risk group (n = 89)	p
Age (year)	63.9 ± 15.7	58.6 ± 15.1	70.8 ± 13.7	<0.001
Gender (male, %)	63 (30.7)	34 (29.3)	29 (32.6)	0.615
BMI (kg/m²)	24.6 ± 6.4	25.5 ± 7.5	23.4 ± 4.4	0.022
BSA (m²)	1.7 ± 0.2	1.7 ± 0.3	1.7 ± 0.2	0.141
CVD (%)	65 (31.7)	40 (34.5)	25 (28.1)	0.33
Hypertension (%)	89 (43.4)	42 (36.2)	47 (52.8)	0.017
Type 2 DM (%)	54 (26.3)	22 (19.0)	32 (36.0)	0.006
CRF (%)	21 (10.2)	3 (2.6)	18 (20.2)	<0.001
SOFA	6.2 ± 5.2	5.0 ± 1.9	7.8 ± 2.2	<0.001
APACHE-II	14.8 ± 5.2	11.6 ± 2.5	19.0 ± 4.8	<0.001
Infection (%)	74 (36.1)	30 (25.9)	44 (49.4)	<0.001
S/P AKI (%)	19 (9.3)	3 (2.6)	16 (18.0)	<0.001
Shock (%)	48 (23.4)	11 (9.5)	37 (41.6)	<0.001
Vasopressors (%)	86 (42.0)	39 (33.6)	47 (52.8)	0.006
MV (days)	3.6 ± 6.5	2.5 ± 5.7	5.1 ± 7.2	0.003
ICU mortality (%)	21 (10.2)	2 (1.7)	19 (21.6)	<0.001
length of ICU stay (days)	5.1 ± 7.4	3.4 ± 4.7	7.3 ± 9.5	<0.001
Total hospital stay (days)	20.7 ± 18.9	19.8 ± 19.1	22.0 ± 18.4	0.398
m-NUTRIC score (median) [IQR]	4 [3-5]	3[2-4]	6[5-7]	<0.001
Admission diagnosis				
Cardiovascular disease %	66 (32.2)	42 (36.2)	24 (27.0)	0.16
Liver/GI disease %	61 (29.8)	30 (25.9)	31 (34.8)	0.164
Respiratory disease %	34 (16.6)	28 (24.1)	6 (6.7)	0.001

Data were presented as mean ± standard deviation, median, interquartile range (IQR), or number percentages.

$p < 0.05$ was significant by 2 sample t-test and chi-squared.

APACHE-II = Acute Physiology and Chronic Health Evaluation II; BMI = body mass index; BSA = Body Surface Area; CRF = Chronic renal failure; CVD = cardiovascular disease; m-NUTRIC = modified Nutrition Risk in the Critically ill; MV = mechanical ventilation. AKI = acute kidney injury; SOFA = Sequential Organ Failure Assessment; Type 2 DM = type 2 diabetes mellitus

m-NUTRIC score group, which was higher than those in the low-risk group ($p < 0.001$). The mean duration of ventilator use in all patients was 3.6 ± 6.5 days, and average SICU stays for all patients was 5.1 ± 7.4 days. The SICU mortality was significantly higher in the high risk group (10.3% vs 1.7%).

Comparison between survivals and nonsurvivals was carried out, and the results are summarized in Table 2. The mean APACHE-II in nonsurvivals was 20.9 ± 5.4, while the mean m-NUTRIC score in nonsurvival was 5.9 ± 1.4 ($p < 0.001$). The data showed that the SOFA, APACHE-II, m-NUTRIC score, and shock patients were all significantly associated with higher mortality.

Table 3 demonstrated the results of univariate logistic regression and multivariate analysis for the ICU mortality in these patients, which showed that acute kidney injury, use of vasopressors, m-NUTRIC score, SOFA, and APACHE-II were associated with ICU mortality. The results of multivariate analysis revealed that acute kidney injury (OR = 13.16; 95% confidence intervals [CI] = 3.69–46.92; $p < 0.0001$), m-NUTRIC score were independent predictors of ICU mortality in these patients. Increase of m-NUTRIC score was significantly associated with increased ICU mortality risk (OR = 6.11; 95% CI = 1.20–31.03; $p = 0.029$). Fig. 2 showed the Kaplan-Meier survival curve of these patients. The group of patients with a higher m-NUTRIC score also had an increased ICU mortality compared with patients with a lower m-NUTRIC score (log rank, $p = 0.006$).

To further assess the relationship between m-NUTRIC score and ICU mortality, a receiver operating characteristic curve was used to calculate the area under the curve (AUC), which was 0.801. The data indicated that m-NUTRIC score were significantly associated with ICU mortality with the cutoff score > 4 (sensitivity = 90.5%, specificity = 62.3%, $p < 0.001$, Fig. 3)

4. DISCUSSION

In this study, we aimed to evaluate if the m-NUTRIC score could be used to predict the outcome of patients in ICU, and maybe aggressive nutritional intervention for these patients is beneficial. Our results showed that the m-NUTRIC score is indeed an independent factor of ICU mortality for patients admitted to the surgical intensive care unit. The m-NUTRIC score is also associated with acute kidney injury and prolonged ICU stay.

In clinical practice, malnutrition was observed in most of the patients admitted to ICU; however, the percentage of patients with malnutrition who receive nutritional therapy is still limited. A previous report emphasized that identification and evaluation of patients with malfunction and poor intake are extremely important.[16] This study investigated the use of the m-NUTRIC score in surgical ICU patients. For patients in the critical care unit, poor nutrition is linked to poor outcomes. Rapid deterioration due to disease and surgical stress would cause loss of proteins and calories. Also, nutritional intervention can regulate the inflammatory process and immune function.[2] Some reports pointed out that malnutrition in critically ill patients may have increased acquired hospital infections, ICU stay, the difficulty of weaning ventilator, poor wound healing, general complications, hospital stays, and mortality.[6]

The research regarding the nutritional risk in comorbidities of ICU patients is limited. We found in this study that acute renal injury is associated with higher m-NUTRIC score and also associated with ICU mortality. Postoperative acute kidney injury is a common and severe complication after operation.[17,18] Poor renal perfusion may be the main reason for postoperative acute renal injury. In addition to poor perfusion, hypotension, inflammation, and use of vasopressin will also result in renal tubule ischemia and injury.[17] Acute kidney injury will also lead to

Table 2

Characteristics of survivals and nonsurvivals in 205 SICU patients.

Variables	All patients (n=205)	Survival (n=184)	Nonsurvival (n=21)	p
Age (year)	63.9±15.7	63.9±15.4	63.5±18.5	0.911
Gender (Male, %)	63 (30.7)	53 (28.8)	10 (47.6)	0.077
BMI (kg/m²)	24.6±6.4	24.8±66	22.6±3.8	0.127
BSA (m²)	1.7±0.2	1.7±0.3	1.6±0.2	0.196
CVD (%)	65 (31.7)	62 (33.7)	3 (14.3)	0.07
Hypertension (%)	89 (43.4)	77 (41.8)	12 (57.1)	0.18
Type 2 DM (%)	54 (26.3)	46 (25.5)	7 (33.3)	0.443
CRF (%)	21 (10.2)	17 (9.2)	4 (19.0)	0.16
SOFA (SD)	6.2±5.2	5.9±2.3	8.2±2.9	<0.001
APACHE-II (SD)	14.8±5.2	14.1±4.7	20.9±5.4	<0.001
S/P Infection (%)	74 (36.1)	63 (34.2)	11 (52.4)	0.101
S/P AKI (%)	19 (9.3)	8 (4.3)	11 (52.4)	<0.001
Shock (%)	48 (23.4)	33 (17.9)	15 (71.4)	<0.001
Vasopressors (%)	86 (42.0)	71 (38.6)	15 (71.4)	0.004
MV (days)	3.6±6.5	3.4±6.7	5.6±4.7	0.143
m-NUTRIC score (%)	4.2±1.8	4.0±1.7	5.9±1.4	<0.001
length of ICU stay (days)	5.1±7.4	5.0±7.7	5.9±4.7	0.606
Total hospital stay (days)	20.7±18.9	22.3±19.2	7.9±6.6	0.001
Admission diagnosis				
Cardiovascular disease %	66 (32.2)	63 (34.2)	3 (14.3)	0.064
Liver/GI disease %	61 (29.8)	57 (31.0)	4 (19.0)	0.257
Respiratory disease %	34 (16.6)	33 (17.9)	1 (4.8)	0.124

Data were presented as mean±standard deviation or number percentages.
$p<0.05$ was calculated out by 2 sample t-test and chi-squared.
AKI=acute kidney injury; APACHE-II=Acute Physiology and Chronic Health Evaluation II; BMI=body mass index; BSA=Body Surface Area; CRF=Chronic renal failure; CVD=cardiovascular disease; m-NUTRIC=modified Nutrition Risk in the Critically ill; MV=mechanical ventilation; SOFA=Sequential Organ Failure Assessment; Type 2 DM=type 2 diabetes mellitus.

Table 3

Multivariate analysis of ICU mortality

Variables	Univariate OR (95% CI)	p	Multi univariate OR (95% CI)	p
Gender (Male)	2.25 (0.90-5.60)	0.083		
BMI	0.92 (0.83-1.02)	0.102		
Infection	2.11 (0.85-5.24)	0.107		
Shock	11.44 (4.13-31.69)	<0.0001	4.68 (0.86-25.64)	0.075
AKI	24.2 (7.96-73.54)	<0.0001	13.16 (3.69-46.92)	<0.0001
Vasopressors	3.98 (1.48-10.73)	0.006	1.24 (0.21-7.34)	0.811
m-NUTRIC Score	15.47 (3.50-68.45)	<0.0001	6.11 (1.20-31.03)	0.029

m-NUTRIC=modified Nutrition Risk in the Critically ill; BMI=body mass index; AKI=acute kidney injury. Data were presented as OR=odds ratio; CI=confidence interval. $p<0.05$ was calculated out by logistic regression.

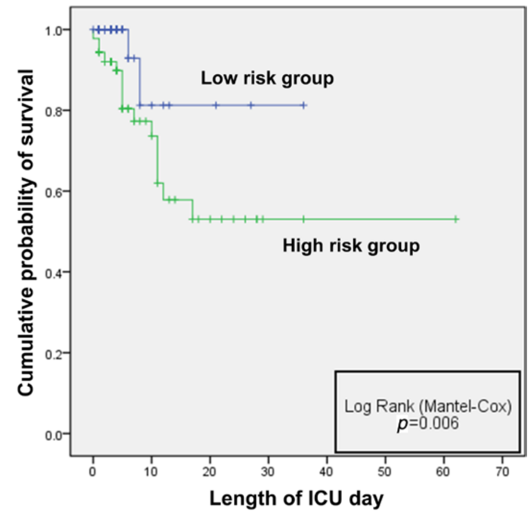

Fig. 2 Survival curves of the patients in high- and low-risk groups.

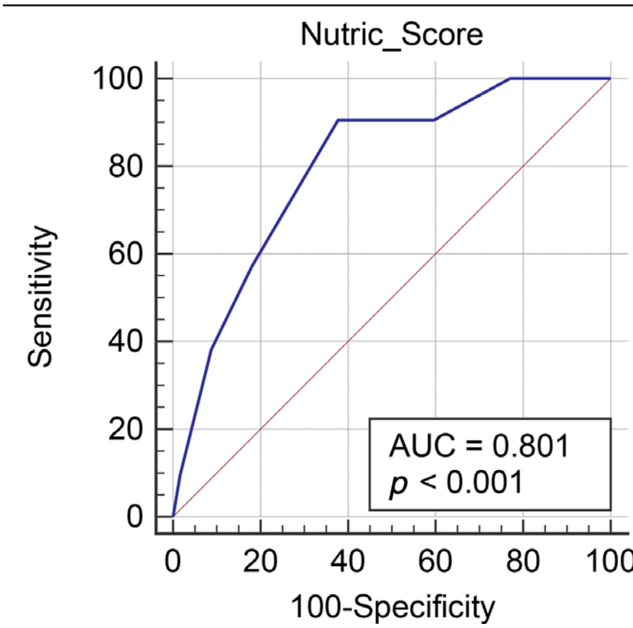

Fig. 3 Receiver operating characteristic curve of m-NUTRIC score in relation to mortality risk.

prolonged hospital stays and poor outcomes, and is more commonly seen after open-heart surgery, which likely resulted from hypoperfusion during cardiopulmonary bypass or high dose of vasopressin use during operations.[18] In this study, 32.2% of our patients went through an open-heart surgery; thus, early nutritional assessment and intervention are important to reduce the incidence of acute kidney injury. These patients may need early nutritional assessment and aggressive intervention to reach the target goal of nutritional support earlier.

Kalaiselvan et al[14] reported that high nutritional risk is associated with longer hospitalization and increased ICU mortality. In our study, there is a significant difference in ICU mortality between patients with m-NUTRIC score ≥5 and patients with m-NUTURIC score <5. These data suggested that patients with higher m-NUTRIC score should receive early nutritional intervention to decrease the nutrition-related complication or mortality. Hudson et al[19] reported in their observational study that when using the guidelines from AND/ASPEN, in patients with high risk of malnutrition, the hospital stay, hospital mortality, and 30-day mortality increased significantly.

The m-NUTRIC score is based on research on Caucasian patients. Several studies have confirmed that this score is applicable to Asian people.[13] Similarly, this study confirmed that the m-NUTRIC score can be used to assess nutritional risk in critically ill patients in Taiwan; the value of AUC curve of m-NUTRIC score was 0.801 when the cut point value was >4 (sensitivity = 90.5%, specificity = 62.3%), which is better compared with some other reports.[4,13,14] This finding is similar to the results of Rahman et al[14] and several other studies. The m-NUTRIC score was developed while accounting for disease severity and designed for assessing critically ill patients. Therefore, an integrated electronic medical record system is needed to automatically calculate these scores.

There are some limitations to this study. First, this is a retrospective observational study. Data were collected from a single medical center, and only cases of patients admitted to the surgical ICU were included. The total case number is limited. Second, the surgical procedures and the disease severity in this group of patients were different. Some bias may be existed. Third, the nutritional support in these patients was lacking, thus whether nutritional intervention in patients with high m-NUTRIC score would improve the outcome was not clear. There are few articles discussing about the prognostic effect of m-NUTRIC score so far. In this article, we found that m-NUTRIC score can be used as one of the prognostic factors in ill surgical patients. Since this is a retrospective study and most of these ICU patients had a short stay in ICU, it is difficult to evaluate the role of nutritional support in patients with high risk of malnutrition according to the m-NUTRIC score. Rather, we concluded in this study that patients with higher m-NUTRIC score had a poor prognosis, which has seldom been investigated before. These descriptions are added in the discussion section of the revised manuscript.

In conclusion, in this study, we found that the high m-NUTRIC score is an independent factor of ICU mortality, and m-NUTRIC score can be used as an initial screening tool for nutritional assessment in patients admitted to surgical ICU. Further investigations to evaluate whether the aggressive nutritional intervention would be beneficial in the SICU patients with higher m-NUTRIC score are mandatory.

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APPENDIX A. SUPPLEMENTARY DATA

Supplemental Figures; http://links.lww.com/JCMA/A81.

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